GeoHealth: A Surveillance and Response System Resource for Vector Borne Disease in the Americas

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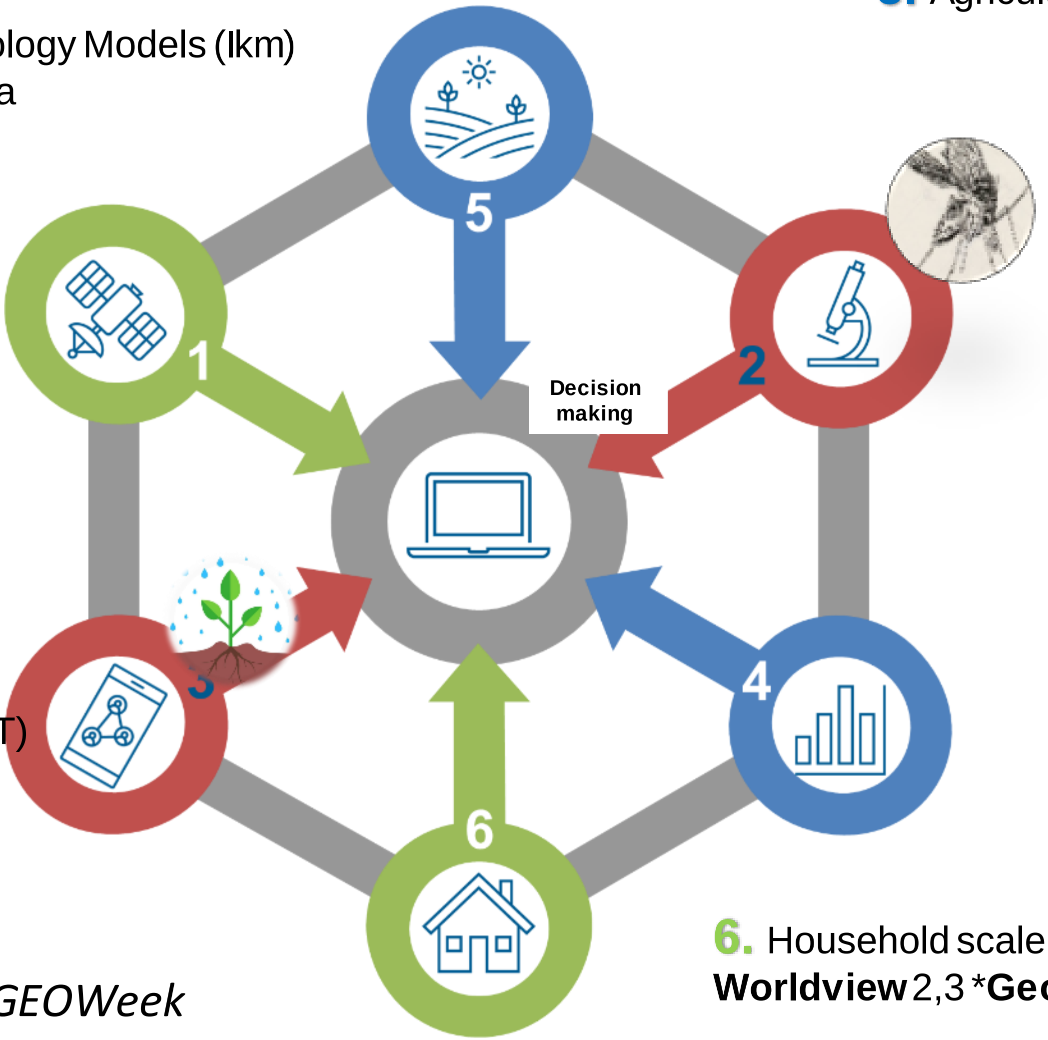
OBJECTIVES

- Construct a geospatial health resource data portal
- Map and model the epidemiological risk of two prototype vector borne diseases: Visceral leishmaniasis and *Aedes* borne arboviruses
- Process big data to discover ‘hidden’ associations of disease for ecological niche modeling vs hypothesis-driven statistical analysis
- Implement dissemination and training programs to promote geospatial mapping and modeling for VBD as envisioned in GEOSS.

Cucuta, COL

SURVEILANCE AND RESPONSE SYSTEM FOR VISCERAL LEISHMANIASIS



1.Satellite Climatology Models (lkm)
2017- 2019 Data
*__VIIRS__-8d LST
*__GPM__ →
*__SMAP__
GOES-16

5. Agriculture scale (30 m)

*__Landsat 8__; Landsat Legacy
*__ASTER__
*__ECOSTRESS__

2. Biology based models vector *Lutzomyia longipalpis*
GDD – Water budget /Generations per year

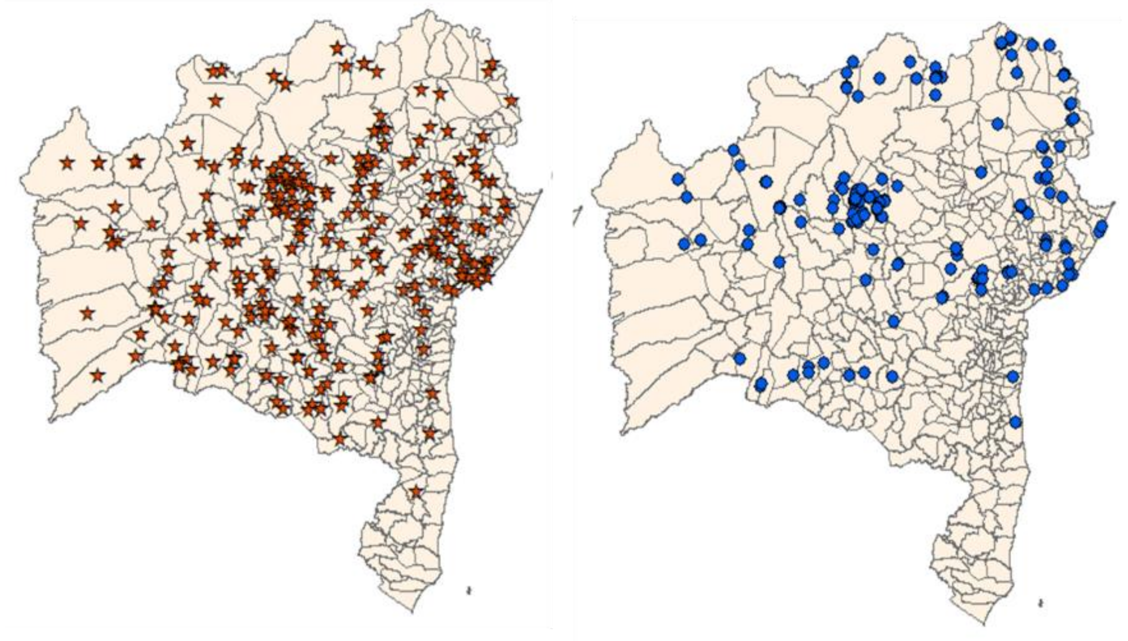
3. WorldClim 2 Model -
30-Year Climate Station
Tmax/Tmin/Prec
Water Budget (Prec/PET)

4. Statistical models

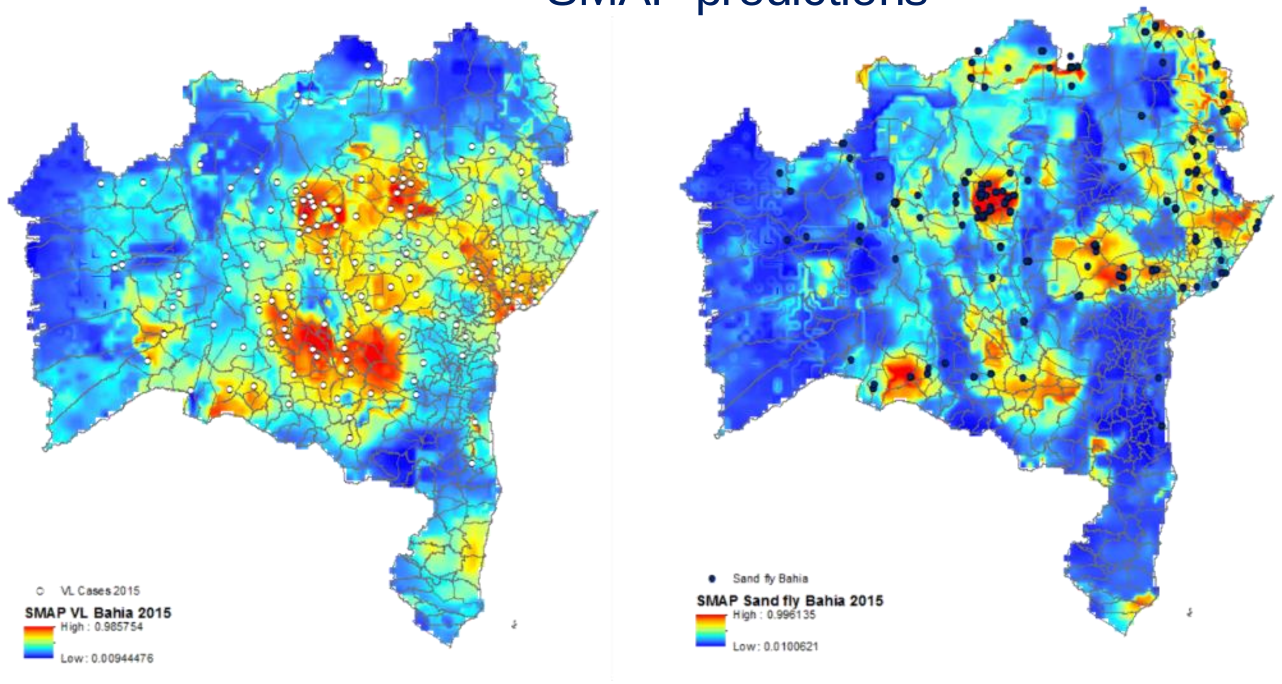
6. Household scale < 1m (Household = epidemiologic unit)
Worldview 2,3 *__GeoEye__

BAHIA STATE

Spatial Distribution



SMAP predictions



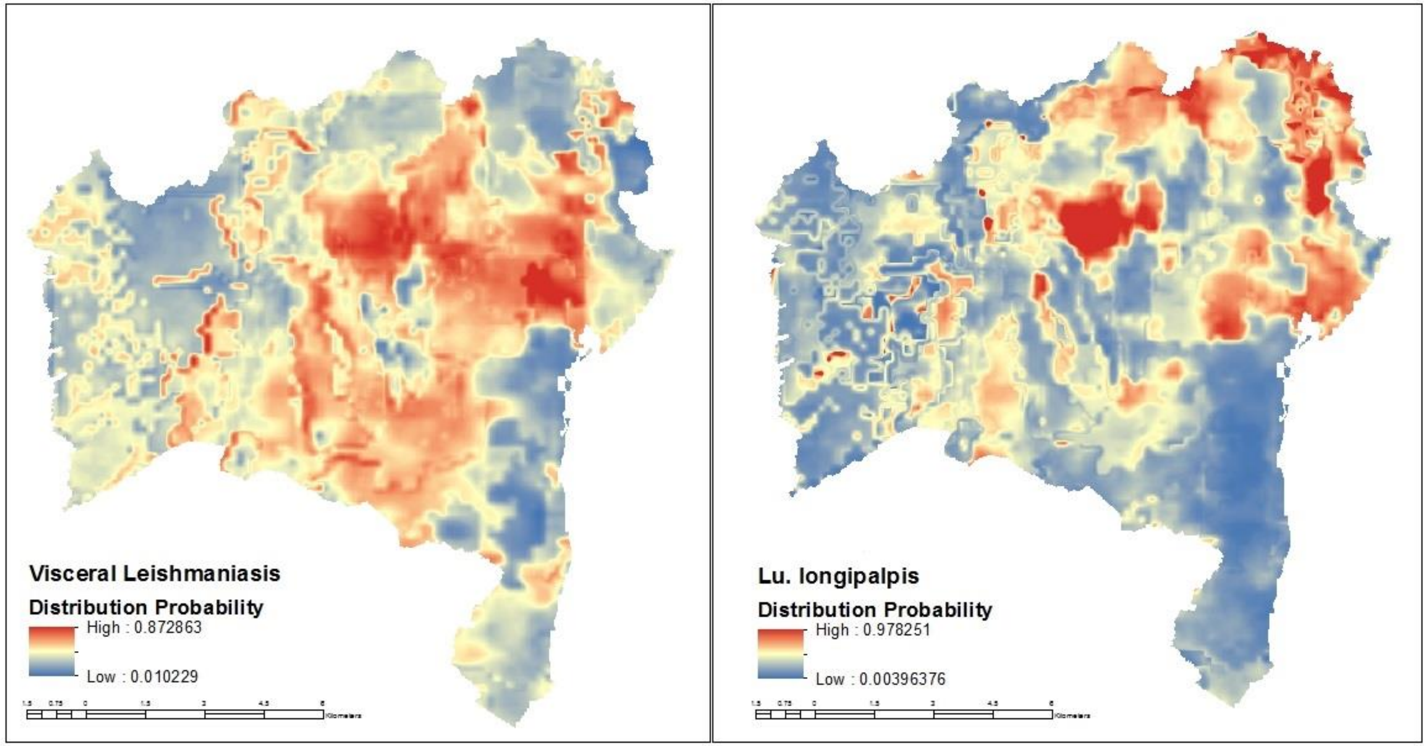
From 2015 to 2018:
VL Cases: 202 municipalities in Bahia
Vector: 76 municipalities in Bahia

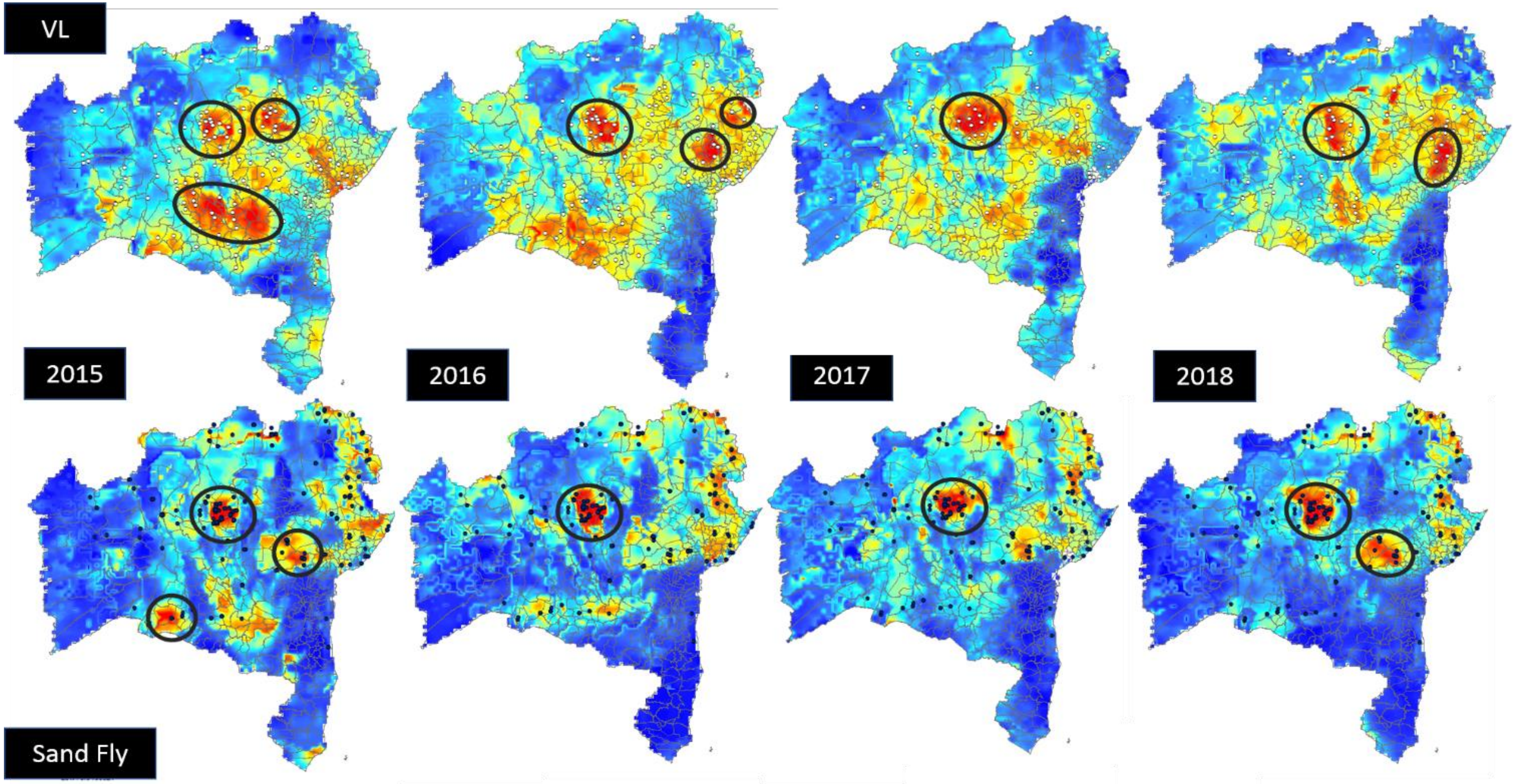
#2021AmeriGEOWeek

Results suggest *Direct* earth observing satellite measurement of soil moisture by SMAP can be used *in lieu* of models calculated from classical thermal and precipitation climate station data to assess VL disease risk and to guide control program interventions.

Visceral Leishmaniasis **_Lutzomyia longipalpis_**

SMAP 1Km Maxent Models




VL
2015
2016
2017
2018
Sand Fly

Growing Degree Day/Water Balance MODEL

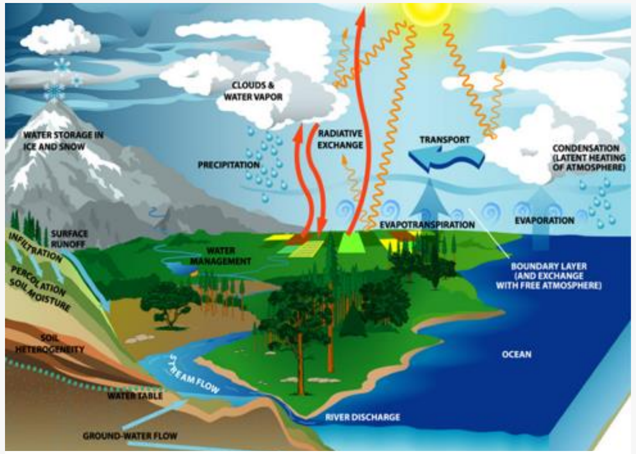
Objective: to define a suitability gradient in the environment for propagation and transmission of the *Lutzomyia longipalpis-Leishmania chagasi* system.

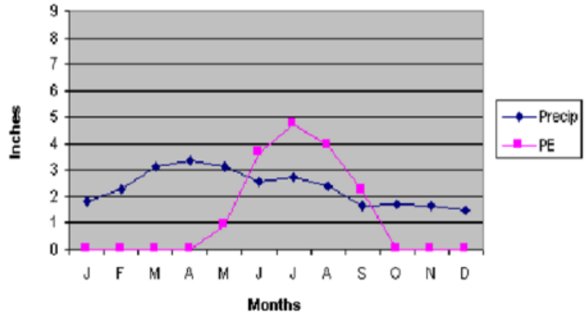
Little data is available in environmental preferences and limits of tolerance in relation to climate.

These factors were estimated by using data from:

- A 30-year average monthly climate surface grid (18 x 18 km cells) of South America including data on:
  - Maximum temperature
  - Minimum temperature
  - Precipitation
  - Potential evapotranspiration (PET)

- Human VL prevalence dataset. (SINAN)
- Developmental data obtained from research studies where *Lu. longipalpis* colonies were established and maintained in the laboratory.



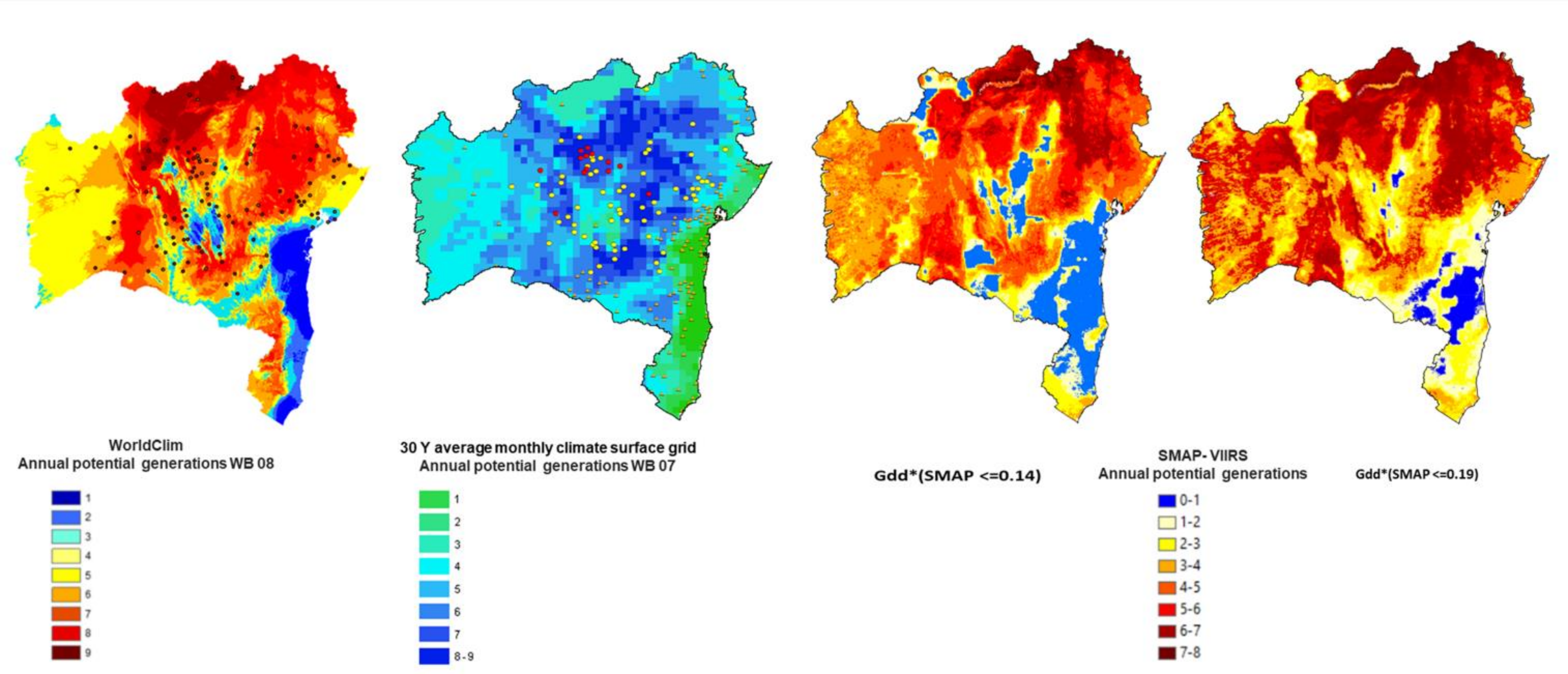


Developmental times, temperature, adults longevity and productivity of *Lu. longipalpis* colony as observed by different authors

Developmental times	At room temperature 25°C[1], relative humidity 80%[2]. From engorge to the first emerge of adults is 35[3]-40[1]days Breed in less constant conditions (48-54)[1] (25-42)[2].
Hatching	4-9 days[1] and 6-9 days[2].
Larvae *First instar* *Second instar* *Third instar* *Fourth instar*	Larvae (four instars)14-19) days[2] 3-5 days (first week)[1] 2-4 days (second week)[1] 1-5 days (send week)[1] 3-9 days (third week)[1]
Pupae	Emergence from pupae on day 10[1] (most of the adults) and 8-9 days[2]. **Few males emerge as early as 7 days**[1]
Adults longevity	From 2 weeks-one month (adults are robust in rough conditions). In females that have taken blood is determined by when eggs are laid (few survive 24 hours after ovoposition). Most live for more than one month[1].
Productivity of the colony	23 generations in 36 months[1] 23/3= 7.7
Cultures of promastigotes and amastigotes	Promastigotes at 22 °C, amastigotes at 34 °C, reversion from amastigotes to promastigotes at 28°C[4]

WATER BALANCE MODEL

Annual Potential Generations - *Lutzomyia longipalpis - BAHIA*

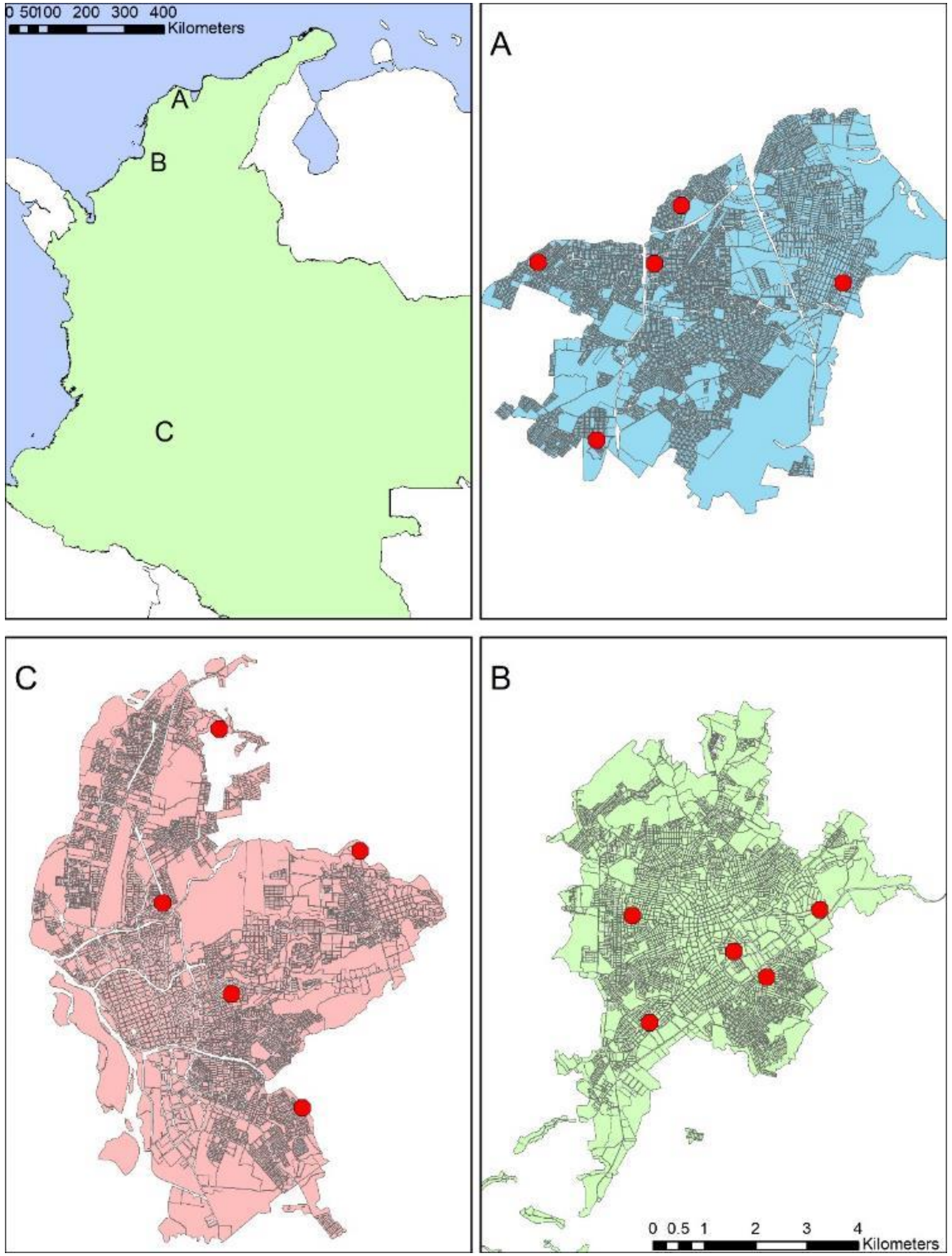

WorldClim
Annual potential generations WB 08

30 Y average monthly climate surface grid
Annual potential generations WB 07

Gdd*(SMAP <=0.14)

SMAP- VIIRS
Annual potential generations

Gdd*(SMAP <=0.19)



Aedes-borne arbovirus risk models in Colombia.

Rebecca C Christofferson and Victor Pena-Garcia

- Study temperature indoors and how it relates to temperature outdoors, at weather stations, and Landsat LST.
- Find a functional relationship to better capture the micro-environment of vectors
- Investigate how differences in temperature measured inside/outside/weather stations/satellite translate to altered estimates of transmission of arboviruses.
- We surveyed 5 houses in 3 different cities in Colombia over the course of a year with installed HOBO^{TM} thermometers. We compiled weather station data available for the three cities (or nearest station) and are currently compiling the satellite readings to complete the dataset.

Figure 1 Location of Soledad (A), Sincelejo (B) and Neiva (C) in Colombia (Left superior panel) and the distribution of Temperature data logger inside each municipality highlighted as red circles.

Extrinsic Incubation Period (EIP). This process is known to be influenced by both intrinsic factors (such as viral strain and/or mosquito population) and extrinsic factors (such as temperature and humidity)

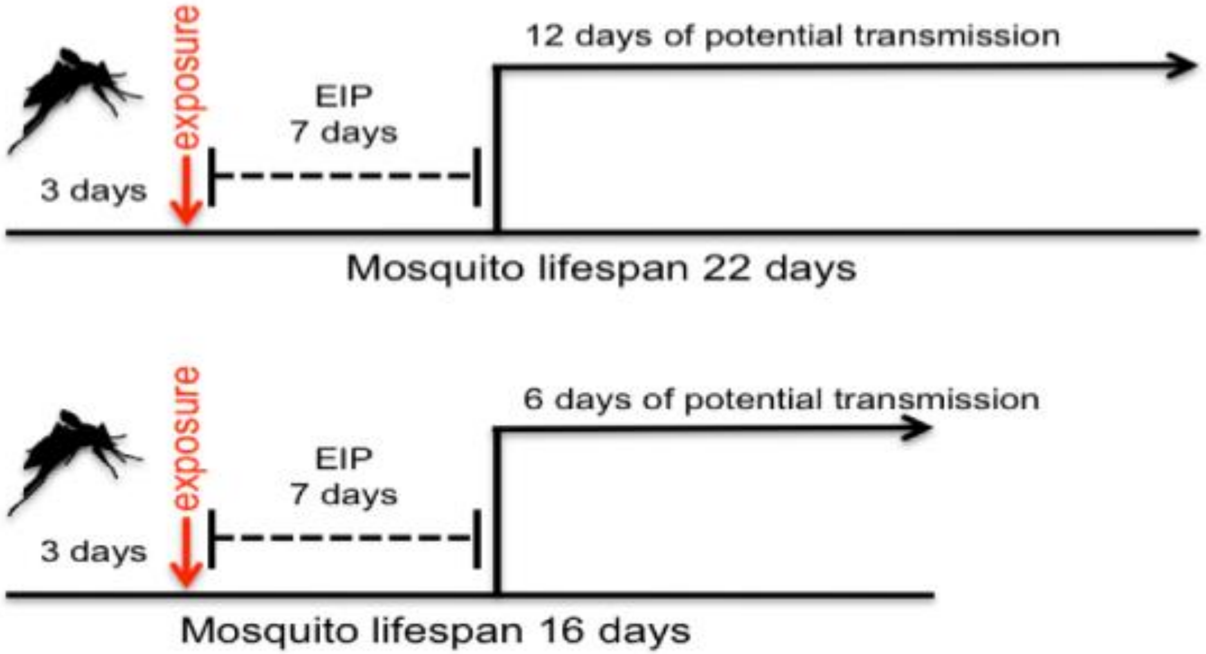


Figure 8 (from Christofferson & Mores 2016): Schematic demonstrating the impact of mosquito mortality on the cumulative transmission potential of an arbovirus.

TRAINING TECHNOLOGY TRANSFER

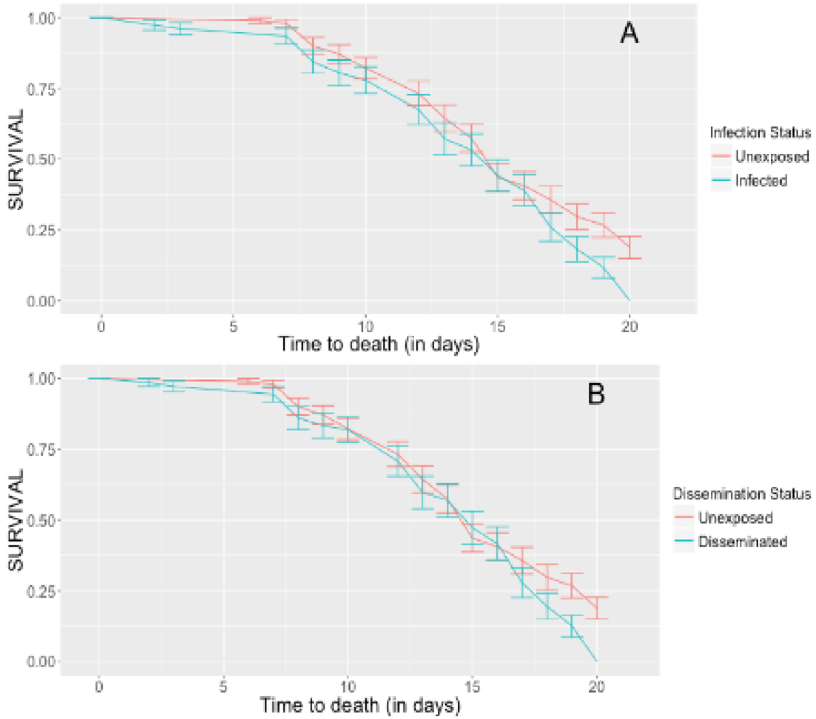


Figure 6 (from Christofferson & Mores 2016): Survival curves for comparisons of A) unexposed to infected mosquitoes at 30°C and B) unexposed to mosquitoes with a disseminated infection were significantly different.

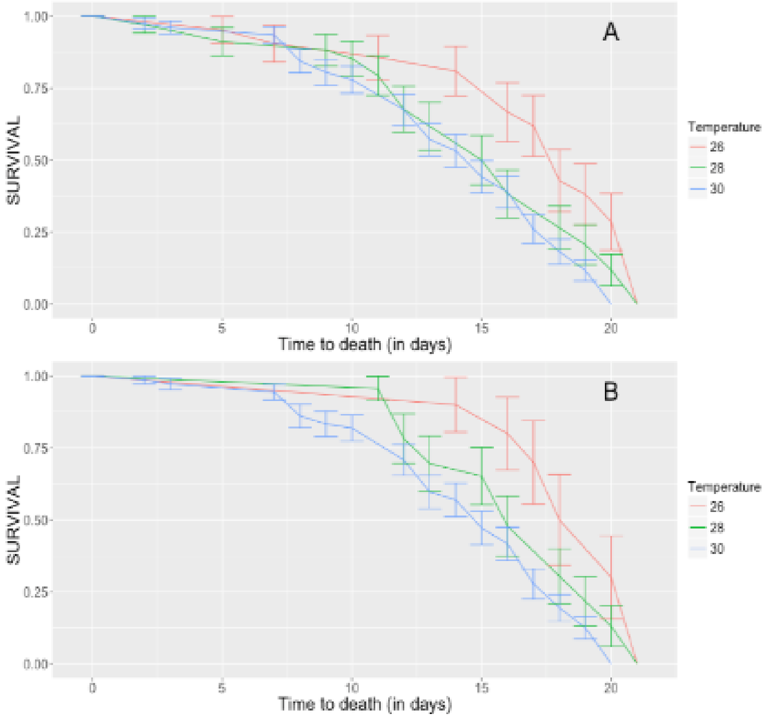
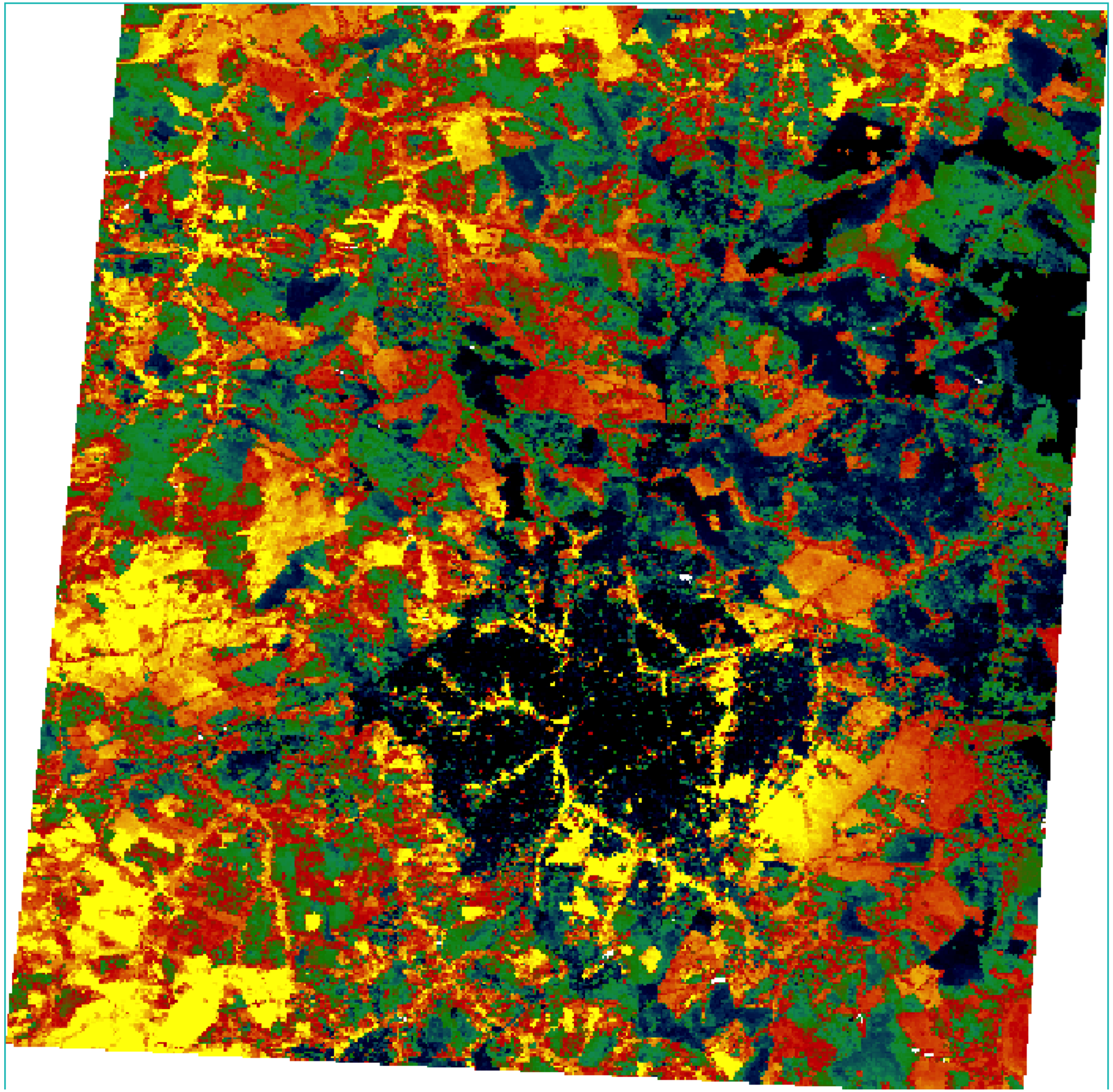


Figure 7 (from Christofferson & Mores 2016): Survival curves for comparisons of A) infected mosquitoes across all three temperatures and B) mosquitoes with a disseminated infection across all three temperatures. Significant differences were found only between 26°C (red) and 30°C (blue) in both cases.



Bauru Daily ET wm-2

2018 Day 256

ECOSTRESS 70m res.

Min
196 wm-2

Max
370 wm-2

Mean
294 wm-2

TRAINING TECHNOLOGY TRANSFER

User friendly course accessible to people in the public health sector, physicians, veterinarians, researchers, students and others interested in infectious diseases.

With GIS tools, it is possible to incorporate drivers and limiting factors that determine disease presence, do analysis, create maps and prediction models.

Implement Municipality Level Geospatial Surveillance and Response Systems fully interactive with municipality health field teams

The goal is mapping vector borne diseases, predicting high-risk areas and future disease outbreaks. It is an effective approach for the study and control of diseases, allocation of health resources, planning, the problem-solving process and policymaking at municipality level

Start	ARL 2
Current	ARL 5
Goal	ARL 6